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# *CADRE Quick-Look*

*Catalyst for Air & Space Power Research Dialogue*



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## *Low-cost Access to Space—Is it Possible?*

Major Kendall Brown

**Problem/Issue.** The high cost of launching payloads into space has limited the United States military's ability to exploit the potential of space in support of national objectives. Today, the average cost to put a payload in low earth orbit ranges from \$4,400 to \$10,000 per pound. Based upon the commercial market elasticity for new and emerging systems, the launch cost needs to decrease by 50-75% to create significantly increased launch vehicle demand. However, is it even possible to dramatically lower cost?

**Background.** Several private companies attempted to develop a low cost launch vehicle during the 1990's. Some went out of business or into bankruptcy, and others began development of a launch vehicle for space tourism market. Most of those companies had responded to a launch vehicle market forecast that predicted a huge increase in demand to support the market for the emerging low earth orbit communication satellite constellation. When low cost launch vehicles were not available to deliver the communication constellations to orbit by the late 1990's, competing communications systems, including terrestrial systems of fiber optic cable and cell phone towers, absorbed the demand. Today, as the commercial space market has matured, launch vehicle performance and reliability are primary attributes because satellite costs are greater than launch costs. For these commercial communication or direct-to-home satellite TV systems, the amortized launch cost only accounts for about 1% of the total cost of providing the services. For those systems, the loss of revenue for a satellite that never gets to orbit, is much more than would be saved with a lower cost launch vehicle. This indicates the commercial space market may not drive the demand for a low-cost launch vehicle. But the Office of Force Transformation believes there is a military need for a low-cost launch vehicle to deploy tactical satellites and for global strike missions.

But why are launch costs so high? Prior to the Air Force Evolved Expendable Launch Vehicle (EELV) program, the high cost of space launch services was due to high demand and low supply of launch vehicles. These launch vehicles evolved from intercontinental ballistic missiles and booster vehicles for manned spaceflight—systems for which performance and reliability were much more important than cost. In some cases the technology was decades old, and the high cost was partially due to small production rates for complicated, high quality precision parts. When NASA began flying astronauts on modified Redstone and Atlas missiles, the vehicles were rated for manned spaceflight through a rigorous quality control system that documented the pedigree of each part starting with the procurement of the raw material. Companies and personnel associated with man-rated spaceflight hardware became personally involved in ensuring that each part met specifications. This type of quality control is very expensive.

Cost predictions for new launch vehicle system concepts are notoriously bad. However, when one thinks about everything that goes into getting a vehicle from the drawing board to the launch pad, it is a roll-up of labor hours, with overhead and profit added at each level of subcontracting, on top of a small amount of raw material cost. Parts produced with higher technology to achieve higher performance have an associated higher overhead. Corporate accounting procedures have led companies to get rid of idle equipment and facilities, leading to more outsourced fabrication and resulting in higher production costs. Added to the actual cost is the cost associated with the "test-fail-fix" cycle during development, and how the corrective actions affect the recurring cost.

The new companies designing launch vehicles in the 1990's attempted to achieve lower cost through different paths, however some of the common threads were simplified systems, shortened development cycles, small teams, and industrial

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materials and fabrication. While intuitively these seem like the right things, they can each introduce technical and programmatic risk. Simple industrial-type parts and systems often have lower performance and reliability, and detailed analyses must be omitted to meet short development schedules with small teams. Some of these start-up commercial launch companies testified to Congress that the government was in their way, and that the government was preventing them from being successful due to the extensive requirements, paperwork, and review processes in preparation for launch from a government launch facility. The range safety requirements for the Eastern and Western Test Ranges are essentially a codification of failure investigation root causes and lessons learned to reduce risk. For example, it dictates factors of safety and other design details developed from and for government missiles and launch vehicles.

A young, entrepreneurial company can keep operating costs low with a lean and mean operation. Dedicated, excited individuals working lots of overtime to do something new and exciting with no extra personnel charging to overhead accounts, few capital expenses, and a focus on the single product. On the other hand, mature, traditional aerospace companies have high overhead costs associated with the critical skills and equipment needed to perform specialized tasks. But as the young company matures, as enthusiasm fades, as overtime can't be sustained, and as failures require the addition of more and more specialized expertise, the company's overhead rises to that of the existing companies.

The Air Force should determine whether it is only a purchaser of launch services from a commercial company or if it intends to develop and operate a new launch vehicle for its uniquely defined requirements? Recalling the Heisenberg uncertainty principle, that the mere act of observing a phenomenon changes the phenomenon, the act of government involvement in a low cost launch vehicle program changes the low cost launch vehicle program. As the government performs its fiduciary oversight responsibilities, and its engineers and managers bring their background, experience, and lessons learned from previous programs to the new low-cost program, they will inevitably change the approach. In most cases the changes will be to reduce program risk, and in most cases, those changes will reduce the likelihood of achieving the low cost objectives.

**Solutions.** A more detailed analysis of the issues introduced is needed. This discussion only addressed expendable launch vehicles; achieving dramatically lower cost access to space may not be appropriate for government participation. Once a company has developed and demonstrated a low cost launch vehicle, the government can consider purchasing launch services, after assessing the payload risk due to the launch vehicle's demonstrated reliability. However, the government must not hinder commercial development and should remove as many obstacles as possible. Currently, the cost of conducting a prototype launch vehicle test program from a government launch range can be equal to, or greater than the cost of the test vehicle itself. The following specific recommendations are made:

1. The US government should absorb and fund the sustainment and operations costs for national launch ranges, and charge users only for direct costs associated with the test.
2. Ranges must stop dictating how a vehicle is designed and what analysis and testing is performed. Instead the range's focus should be on protecting public safety and Range assets. Therefore, the government should fund the development of a modern, simple, low-cost range safety destruct package to destruct the vehicle at any flight path deviation. (Note, the pyrotechnics in a range safety destruct package do not cause significant costs, the cost is associated with the existing pyrotechnic system architecture and its tracking and data relay systems.)

Using this approach, the government cannot become reliant upon or invested into any particular launch vehicle service provider. If a company has a technical, quality, management, or any other type of problem, the government cannot step in to help, it must allow the free market system to work. Otherwise the changes and improvements implemented to satisfy the government that the service is reliable will cause the cost to increase.